drought tips

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How Much Water Are You Applying With Your Low Volume Irrigation System?

During a drought it is particularly important to use only the amount of water necessary for irrigation. Irrigation scheduling, which defines how much to irrigate, is only the first step of irrigation. Once the amount to apply is known, how long the low volume irrigation system should be operated must be determined. Because low volume irrigation systems are easy to operate and can achieve a high degree of uniformity, they are well-suited to drought strategies such as deficit irrigation.

To determine how long the system should operate, it is first necessary to calculate the application rate. Irrigation scheduling and crop water use information is most frequently presented in inches per day (in./day), while discharge from low volume emitters is measured in gallons per hour (gph). The following may be helpful in determining required operating times for low volume irrigation systems.

Drip and Micro-Sprinkler Emitters

The water use of the crop and the application rate of the emission device(s) determines how long drip and micro-sprinklers should be operated.

Step 1 in determining the required operating time is to convert the crop water use information (usually available in inches per day), to gallons per day of plant

Table 1. Crop water use (gal./ day) for various plant spacings and crop water use (in. / day).

Crop Spacing (ft^2)	Crop Water Use (in. / day)							
	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4
100	3	6	9	12	16	19	22	25
200	6	12	19	25	31	37	44	50
400	12	25	37	50	62	75	87	100
600	19	37	56	75	93	112	131	150
800	25	50	75	100	125	150	174	199
1000	31	62	93	125	156	187	218	249
1200	37	75	112	150	187	224	262	299
1400	44	87	131	174	218	262	305	349
1600	50	100	150	199	249	299	349	399
1800	56	112	168	224	280	336	392	449
2000	62	125	187	249	311	374	436	498
2200	69	137	206	274	343	411	480	548
2400	75	150	224	299	374	449	523	598

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water use. The following formula may be used (or see Table 1):

Water Use by the Plant (gal./day)	=	Plant Spacing (ft^2)	x	Crop Water Use (in./day)	x	0.623

For example: Tree crop spacing = 20 ft. x 20 ft. = 400 ft^2

Crop water use = 0.3 in./day

Water use by the plant (gal./day) = 400 ft^2 x 0.3 in./day x 0.623

= 75 gal./day

Step 2 is to determine the application rate of the irrigation system in gallons per hour (gal./hr.). For both drip emitters and micro-sprinklers, this requires determining: (1) the number of emission devices per plant, and (2) the discharge rate per emission device (gal./hr./emitter):

Application Rate (gal./hr.)	=	Number of Emission Devices	x	Discharge Rate per Emission Device (gal./hr./ emitter)

For example :

Drip emitters: 4 drip emitters per tree

Discharge rate per emitter = 1 gal./hr.

Application rate = 4 emitters/tree x 1 gal./hr. per emitter (gal./hr.)

= 4 gal./hr.

Micro-sprinklers:

Discharge rate per micro-sprinkler = 12 gal./hr.

Application rate = 1 micro/tree x 12 gallons/hour (gal./hr.)

= 12 gal./hr.

Step 3 is to determine the operation time of the irrigation system in hours per day. This requires using the crop water use (determined in Step 1) and the application rate (determined in Step 2). The following formula may be used (or see Table 2):

Hrs. of operation per day (hrs./day)	=	Crop water use (gal./day)	÷	Application rate (gal./hr)

Table 2. Hours of operation per day for various application rates (hrs./ day) and crop water use (gal./ day).

Crop Water Use (gal./ day) \ Application Rate (gal. / hr.)	1	2	4	6	8	10	12	14	16	18	20
5	5.0	2.5	1.3								
10	10.0	5.0	2.5	1.7	1.3	1.0					
15	15.0	7.5	3.8	2.5	1.9	1.5	1.3	1.1			
25		12.5	6.3	4.2	3.1	2.5	2.1	1.8	1.6	1.4	1.3
50			12.5	8.3	6.3	5.0	4.2	3.6	3.1	2.8	2.5
75			18.8	12.5	9.4	7.5	6.3	5.4	4.7	4.2	3.8
100				16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0
125				20.8	15.6	12.5	10.4	8.9	7.8	6.9	6.3
150					18.8	15.0	12.5	10.7	9.4	8.3	7.5
175					21.9	17.5	14.6	12.5	10.9	9.7	8.8
200						20.0	16.7	14.3	12.5	11.1	10.0
225						22.5	18.8	16.1	14.1	12.5	11.3
250							20.8	17.9	15.6	13.9	12.5
275							22.9	19.6	17.2	15.3	13.8
300								21.4	18.8	16.7	15.0
325								23.2	20.3	18.1	16.3
350									21.9	19.4	17.5
375									23.4	20.8	18.8
400										22.2	20.0
425											21.3
450											22.5
475											23.8

For example :

Drip emitters:

Crop water use (gal./day) = 75 gal./day (Step 1)
Application rate (gal./hr.) = 4 gal./hr. (Step 2)
Hrs. of operation = 75 gal./day ÷ 4 gal./hr.
per day (hrs./day)

= 18.8 hrs. /day

Micro-sprinklers:

Crop water use (gal./day) = 75 gal./day
Application rate (gal./hr.) = 12 gal./hr.

Hrs. of operation = 75 gal./day ÷ 12 gal./hr
per day (hrs./day)

= 6.3 hrs./day

(Table 2 reveals the same hours of operation for these examples.)

Drip Tapes and Tubings

Drip tapes and tubings placed on the soil surface or subsurface are commonly used for row crops. Determining daily operation times for these systems is somewhat more complicated than for drip emitters and micro-sprinklers, but follows a similar three-step process. The discharge rate of drip tapes and tubings is usually given in gallons per minute per 100 feet of material (gal./min. per 100 ft.).

Step 1 is to determine the crop water use in inches per day (in./day), which is the standard measure used in evapotranspiration (ET)-based methods of irrigation scheduling.

Step 2 is to determine the application rate of the drip tape or tubing in inches per hour (in./hr.). Table 3 can be used to make this determination if the row spacing and the irrigation system application rate (gal./min. per 100 feet) are known.

Example : Row spacing = 60 inches
Drip tape application rate = 0.5 gal./min. per 100 ft.

From Table 3, the application rate (in./hr.) = 0.1 in./hr.

Table 3. Application rate (in. / hr.) of drip tapes and tubings for various flow rates and spacings

Row Spacing (in.)	Flow Rate (gal. / min. per 100 ft.)								
	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50
10	0.12	0.17	0.23	0.29	0.35	0.40	0.46	0.52	0.58
15	0.08	0.12	0.15	0.19	0.23	0.27	0.31	0.35	0.39
20	0.06	0.09	0.12	0.14	0.17	0.20	0.23	0.26	0.29
25	0.05	0.07	0.09	0.12	0.14	0.16	0.18	0.21	0.23
30	0.04	0.06	0.08	0.10	0.12	0.13	0.15	0.17	0.19
35	0.03	0.05	0.07	0.08	0.10	0.12	0.13	0.15	0.17
40	0.03	0.04	0.06	0.07	0.09	0.10	0.12	0.13	0.14
45	0.03	0.04	0.05	0.06	0.08	0.09	0.10	0.12	0.13
50	0.02	0.03	0.05	0.06	0.07	0.08	0.09	0.10	0.12
55	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.11
60	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
65	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.09
70	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.07	0.08
75	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.07	0.08
80	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.06	0.07

Step 3 is to determine the irrigation system operation time (hours) necessary to satisfy the crop water needs. This requires the crop water use (determined in Step 1), and the application rate (determined in Step 2). The following formula may be used (or see Table 4):

Hrs. of operation per day (hrs./day)	=	Plant water use (in./day)	+	Application rate (in./hr.)

Example: : Crop water use = 0.3 in. /day
System application rate = 0.1 in. /hr
Hrs. of operation = 0.3 in. /day + 0.1 in./hr
per day (hrs./day)

= 3 hrs./day

Table 4 reveals the same operation time for this example.

Table 4. Operation time (hrs / day) for various application rates (in. / hr.) and crop water use (in. / day)

Plant Water Use (in. / day) \ Application Rate (in. / hr.)	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
.05	1.0	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1
0.1	2.0	1.0	0.7	0.5	0.4	0.3	0.3	0.3	0.2	0.2
0.15	3.0	1.5	1.0	0.8	0.6	0.5	0.4	0.4	0.3	0.3
0.2	4.0	2.0	1.3	1.0	0.8	0.7	0.6	0.5	0.4	0.4
0.25	5.0	2.5	1.7	1.3	1.0	0.8	0.7	0.6	0.6	0.5
0.3	6.0	3.0	2.0	1.5	1.2	1.0	0.9	0.8	0.7	0.6
0.35	7.0	3.5	2.3	1.8	1.4	1.2	1.0	0.9	0.8	0.7
0.4	8.0	4.0	2.7	2.0	1.6	1.3	1.1	1.0	0.9	0.8

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